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The commencement of a new volume of this Journal, affords a suitable occasion for announcing such arrangements as have been made, with a view to increase the value of the matter contained in its pages. Guided by past experience, it has been our aim to enlist as many contributors as possible. We have accordingly obtained from several distinguished professional gentlemen the promise of contributions. It was intended to announce the names of those who had been so kind as to lend their aid (permission having been given so to do,) but time enough to hear from those already addressed, not having elapsed, we prefer waiting until the next number appears. Numerous engagements have prevented us from making application to many of our oldest friends, whose readiness to assist us has always been shown by frequent communications. We would therefore respectfully request that all who may feel disposed to be enrolled in our list of contributors, should send us their assent at their earliest convenience.

We are most happy to embrace this opportunity of returning thanks to those gentlemen who have hitherto favored us with communications, as well as to those who have so kindly and promptly answered our more recent call.

It will thus be seen that the pages of the Railroad Journal will embody a complete system of practical engineering, adapted to the various circumstances of our extensive territory. The names of the writers as well as the character of the articles will be sufficient to show the correctness of our assertion.

New Experiments on Friction.

As an additional means of giving variety and value to the work, it is proposed to give original translations and abstracts of such French professional papers as may be deemed suitable.

If sufficient encouragement is offered, a series of original articles may be expected on the most important topics relating to the theory and practice of the profession. Without entering more into detail at present, it is proposed to leave the value of these improvements to be estimated rather from the pages of the work, than from any mere assertions on our part.

In conclusion, we have only to remark, that if the same spirit of kindness, and desire to support the Journal which has already been manifested in several quarters, is continued and extended, we have no hesitation in promising, under such auspices, a corresponding effort on our part to do every thing tending to the satisfaction of our readers.

NEW EXPERIMENTS ON FRICTION, MADE AT METZ, IN 1831, 1832, AND 1833, BY ARTHUR MORIN, CAPT. OF ARTILLERY.

(Translated and abridged for the American Railroad Journal.

Remarks by the Translator.—A well conducted and extensive series of experiments upon friction, has long been a desideratum in mechanical science, both for the specific application of particular results, and for the general laws deducible only from trust worthy and exact experiments.

The best treatises extant upon this subject have hitherto led to approximate or even erroneous laws, and hence their authority, when followed out into extreme cases, has been shown to be worth but little. For instance, the application to railroad mechanics, where great pressure and high velocities are concerned, has proved so fallacious in many cases, that hypothesis has been freely used to reconcile well observed facts with the laws as originally announced.

The experiments of Mr. Morin are of a different character, undertaken at the request of the French government, and carried on at their expense—advantages have been afforded inaccessible to previous observers. The result has been, an accuracy sufficient to confirm in the most satisfactory manner the general laws of friction, together with special results of the highest value for immediate practical use.

Another remarkable advantage to be derived from the labors of M. Morin, is this—they may safely be taken as the ground work of all future experiments, and thus other observers in this department of science, instead of painfully retracing each step, may confident-

ly go on from where M. Morin has left off, and add new facts without re-examining those which may be assumed as established.

The uncommon ingenuity manifested in the contrivances of M. Morin, have almost tempted us to go into the detail of his machinery and calculations. This, however, could not be done without very cumbersome plates and a formal copy of so large portions of the works as to greatly exceed the space which we can afford. We have, therefore, preferred the report of the committee, which, from its succinct account of the mode of operation, and the high reputation of its author, is worthy of attentive perusal.

In future numbers we intend to give, if necessary, some of the general results of the author, and the whole of his numerical results condensed into one complete table.

REPORT OF A COMMITTEE OF THE ACADEMY OF SCIENCES, UPON
THE NEW EXPERIMENTS ON FRICTION, BY M. MORIN.

Com. Messrs. Poisson, Arago, and Navier.

The Academy has heard with much interest, the summary which has been read by M. Morin, of the results which he has obtained. The object of these new researches, has a most important influence in physics and the mechanic arts, and the processes employed by the author are very remarkable, and seem to give superior exactness and precision to experiments of this sort.

The resistance arising from friction is the principal cause of the loss of power which cannot be avoided in the use of machines. It appears that the first attempts to estimate its influence are due to Amontons, whose paper is inserted in the Memoirs of the Old Academy of Sciences for the year 1699. According to this skilful physician,* the resistance of friction is independent of the extent of the surfaces in contact, which, since then, has been confirmed; moreover, that this resistance is very nearly the same for different substances, such as wood, iron, copper, lead, etc., when the surfaces are covered with grease, and its value is about one-third of the pressure of one body upon the other.

These results served for a long time as a guide to mechanics.—But Coulomb having presented to the Academy of Science, for a prize offered in 1781, a very extensive treatise, containing numerous and varied experiments, for the measurement both of friction

* We do not hesitate to use this word in the sense in which it is used in the original, and which is now becoming quite usual in Europe. No single word has hitherto been employed to denote a person devoted to the study of physics, but the vague and imperfect term *philosopher* or *natural philosopher* has been adopted. This might, with equal propriety, be applied to the Astronomer, the Chemist, Zoologist or Mathematician. [Ed.]

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and of the rigidity of ropes, the rules deduced from it have been generally admitted.

The work in question, published in 1785, in the tenth volume of the *Savans étrangers*, from the justly celebrated name of its author has acquired great authority—but, nevertheless, if we compare it with the observations presented by M. Morin, we shall find ourselves compelled entirely to reject a part of the results which it contains.

The mode of observation employed by Coulomb consisted in causing one body to slide horizontally over the other, by means of a weight suspended from a cord passing over a pulley. The velocity of the motion was estimated from the time consumed by the sliding body in passing over each half of a space six feet, and sometimes even only four feet in length.

The results present very great inequalities, and are not in general sufficiently numerous, in each series of experiments to give entire certainty to the conclusions.

Such as they are, they have in all cases led the author so far as to announce the general laws of the phenomenon, which consists chiefly in this, that the resistance due to the friction of solid bodies is proportioned to the pressure of one body upon the other, and is independent of the extent of the surfaces in contact, and of the velocity of the motion. It appears even, according to the recent experiments, that these laws are more generally exact and less subject to exceptions than Coulomb himself had thought.

This physician appears to have been the first to recognise the necessity of distinguishing in the estimation of friction, the case of a continual motion, and that in which the two surfaces which have been in contact for sometime, separate and commence to slide the one upon the other. But the numerical values of the intensity of friction which are given in his Memoir, for these two cases, are not at all confirmed by the results obtained by M. Morin.

In the volume of the *Philosophical Transactions* of the Royal Society of London, for the year 1785, we find some experimental researches by Dr. Vince, whose results do not entirely agree with those of Coulomb. These experiments having been made on a very small scale do not appear to be of a character capable of giving us exact notions upon this subject. We may say the same in regard to the more recent experiments of Mr. George Rennie, published in the volume of the same collection for the year 1829.*

* This paper was republished in the 4th and 5th vols. of the Journal of the Franklin Institute, and contains the most recent experiments of any extent hitherto accessible to the English reader. [Ed.]

The mode of observation was nearly the same, as well as the principal numerical values. We may remark among the latter, the measurement of the friction of steel skates sliding upon ice, for which the author found various results, comprised between the 24th and the 70th of the pressure. This resistance would be far less than all those which have been observed, even in the case of the hardest and most polished metals.

In regard to the observations made by M. Morin (the results of which are announced in the Memoir presented Dec. 12th, 1831, and an additional note, Feb. 6, 1832,) they are distinguished by various circumstances, according to which, it appears that they should give more exact and satisfactory results than all those which have hitherto been published.

First. The slide was made to pass over a much greater space, (nearly 4 metres—13 ft.) which allowed the nature of the motion communicated to be ascertained with greater certainty.

Second. The force acting upon the slide by which the friction was overcome, could be calculated by knowing the amount of the descending weight, having proper regard to the resistance arising from the friction and inertia of the pulley and to the rigidity of the cord. The author actually made this calculation with great care in determining the resistances of which we have spoken by special observations. But besides this, all the successive values, thro' which the force acting upon the slide, passed during each experiment, have been directly observed by means of an ingenious apparatus, the idea of which was given to the author by M. Poncelet, officer of Military Engineers, and Professor of the School for the application of Artillery and Engineering. This apparatus consists of a spring by which the force in question is transmitted, and which carries a moveable pencil, the position of which varies according to the tension of this spring. While the spring is in play, a disk carried with it, by the progressive motion of the slide, and moved circularly by the effect of the same motion, receives the mark of the pencil and thus preserves a faithful imprint of all the variations which can take place in the tension of the cord by which the slide is continually drawn. These two processes, altogether distinct, have exactly agreed in giving the same values for the tension.

Third. The nature of the motion communicated to the slide has been observed with an exactness no less remarkable, by a method analogous to the preceding. This last process consists in the employment of a piece of clock work, placed in a fixed posi-

tion, and which communicate to a pencil a regular motion by which it describes, with a constant velocity, verified at each experiment, a circle of 0.14 metre, ($5\frac{1}{2}$ inches) in diameter. A disk is fixed to the axis of the pulley to which the descending weight communicates a rotatory motion, which is always in a determined proportion to the progressive motion of the slide ; a sheet of paper placed upon this disk receives the mark of the pencil. The curve traced affects various figures, the nature of which is determined by the combination of the proper and regular motion of the pencil and of the motion, sometimes uniform, oftener variable, communicated to the slide and the pulley by the motive weight and the resistance to be overcome. The success of these delicate processes has required great study and care. The author uses a very delicate hair pencil filled with India ink. The traces of the curves obtained in these experiments, a great number of which have been exhibited to the Academy, show the extreme of delicacy and regularity, and evidently leave no uncertainty as the appreciation of the results which they are intended to exhibit.

The frictions hitherto studied by M. Morin* are those of woods, either dry or moistened with water, sliding upon each other, of iron, brass, of leather and cordage, dry or moist, upon oak. The elements of observation have varied within much wider limits than in the experiments of Coulomb. The velocities having been carried beyond 3 metres (9 ft. 10 in.) per second, the extent of surface as high as 30 sq. decimeters (465 sq. inches,) and the pressure as high as 1100 kilogrammes, (2430 lbs.) In all these experiments the motions observed have been strictly uniform, uniformly accelerated or uniformly retarded and thus indicate plainly that the resistance due to friction is constant and independent of the velocity of motion. Moreover this resistance has been found equally independent of the extent of the surfaces in contact, and exactly proportioned to the pressure.

The general laws announced by Coulomb are thus found to be confirmed, and as we have said above, the result of the experiments, at least, for those circumstances under which observations have been made, that is for the case where the substances are dry or moistened with water, and where no coating of a greasy nature has been employed, lead us to think that the laws in question should be regarded as in exact conformity with natural effects, and not mere approximate rules which we could employ in the application to the arts without the risk of any dangerous error.

* It is to be remembered that this remark applies to the first of the three Memoirs. [Ed.]

The author as well as Coulomb, has recognized the necessity of distinguishing the momentary effort necessary to separate two surfaces which have been for some time in contact, and the continued effort which is exerted during the sliding. The first of these two forces is generally much greater than the second. It appears, too, that its value does not present the same constancy and regularity, that it varies according to certain accidental circumstances, and that it cannot be fixed with the same degree of precision. Moreover, M. Morin has observed a remarkable fact, which is this, that always when the slide at rest is solicited by a force sufficiently great to overcome the friction which should take place in a continued motion, but too small to cause the first separation of the surfaces in contact, a slight vibration given to the apparatus is sufficient to start the sliding body. It results from this observation, that when it is desired to measure the forces which are necessary to retain in a state of equilibrium, a construction exposed to any shocks, it would not answer, in general, to attribute to the resistance due to friction a greater intensity than that which is manifested in the case of a continued motion.

In regard to the absolute values found in these experiments for the relation of the friction to the pressure, they differ much from the results given by Coulomb, and lead us to attribute a much higher degree of intensity to this kind of resistance. Thus, according to M. Morin, the friction of wood sliding upon wood, when dry, or of iron upon oak, presents in the case of a continued motion, values comprised between .32 and .62 of the pressure, while, according to Coulomb, the same friction presents values between .7 and .17 of the pressure. The difference of these results cannot, evidently, be ascribed to errors of observation; we must necessarily admit that the two observers have not operated under similar circumstances.

M. Morin remarks, that in the friction of wood upon wood, or of metal upon wood, when there is no coating of grease, repeated sliding does not polish the surfaces—on the contrary, the surfaces mutually wear away, and this alteration shows itself by the formation of grains of dust which must be removed from time to time, in order that the nature of the results may not be changed. It is no longer the same when the surfaces of the sliding bodies are impregnated, even slightly, with grease, and the intensity of the friction is considerably diminished thereby. The author believes that this observation will explain the want of agreement between the results which he has obtained and those presented by Coulomb. He supposes that in the experiments which are given

by this celebrated physician as having been made with dry wood or metals sliding upon each other when dry, substances may have been used, which, in a preceding experiment had been covered with grease, which he had satisfied himself with merely wiping off, while he should have entirely renewed the surfaces. We abstain from pronouncing an opinion upon this subject, in order to do which it would be necessary for us to undertake special researches to which we are not able to devote ourselves.

Whatever may be the explanation of the discrepancy referred to, the work presented by M. Morin appears to deserve great confidence, on account of the number and extent of the observations—the agreement of the results, and the nature of the new and remarkable processes which have been employed.

It would be superfluous to insist, in this place, upon the importance of researches of this nature, to the progress of physical science, the arts—constructions and mechanics, properly so called—or upon the real utility of the pains and expense bestowed upon these researches, which have been made at the public cost by the orders of the minister of war. We think that the Academy should approve the work presented by M. Morin by ordering its insertion in the collection of the *Savans étrangers*, and encourage him by its vote to continue his researches and extend them as far as possible.

Poisson,

Arago,

Navier.

For the American Railroad Journal and Mechanics' Magazine.]

**INJUDICIOUS CONSTRUCTION OF RAILWAYS, AND THEIR MACHINERY
IN THE UNITED STATES.**

In the Journal of the Franklin Institute for May, is contained an article on the injudicious policy pursued in the construction and machinery of many railroads in the United States, by John C. Trautwine, Civil Engineer.

These remarks by Mr. Trautwine, have been induced by the perusal of Mr. Ellet's pamphlet on the same subject, which has already been noticed in this Journal, and about which there has been some controversy. The complimentary tone in which he speaks of that pamphlet, at first, caused us to fear that he was about to endorse *Mr. Ellet's wooden road, without grading, to cost \$1000 per mile, and with a half of a ton engine*; but we have been greatly disappointed on finding that he does not countenance a road below a cost of

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\$10,000 per mile, with an engine of 6 to 8 tons, which, at the present prices of labor and materials, would build a road with an edge rail, and furnish it, comprising a fair proportion of the indispensable ingredients of *power, speed, and safety*. So far we feel relieved.

There are, however, some views of Mr. Trautwine in regard to the failure of railways, which, like those of Mr. Ellet, may be noticed as to broad. They assume that the causes of all our misfortunes in railways are to be found,

1st. *In a departure from first principles by our Engineers as a class.*

2d. *In a too imitative propensity in our people, and among our Engineers in particular.*

The first cause, is, we suppose, interpreted to mean either that *too much money* had originally been laid out on our roads, as based on the supposed trade and travel expected to be done by them—or that our Engineers were not gifted with the requisite prescience to enable them to avoid all difficulties in a new enterprise, at the first jump. In looking around among all the river lines, we find that they have all, more or less, been actively engaged, very shortly after their completion, in remedying the defect, found radical in nearly every department, of *too little money* having been *fairly* spent on them, and counting the miserable abortions of speculations; but looking at all the notable routes of railway, there is yet living evidence about them, that if a violation of first principles of that sort attaches, it has been one of parsimony and not one of prodigality. A road may have cost a great deal, without a due proportion having been faithfully applied towards its judicious construction.*

There can be yet, nothing *fully* determined, or final, about ei-

* Pennsylvania has been peculiarly the victim of bad and extensive railways. Her main one, the Columbia, has had to be relaid. All the minor ones, such as the Norristown, the Trenton, the Woodbury, the Little Schuylkill, Bearer Meadow, Danville and Pottsville, Mountjoy, Chambersburg, Elmira, etc., having flat bars, and otherwise too cheaply built, have all been rendered nearly useless under the effect of the lightest useful locomotive. The sufferers by these roads are the most effective denouncers of the improvement generally; and it is not to be wondered at that the public mind in Pennsylvania is so wrongly impressed in regard to it. All this has tended much to increase the difficulty and opposition otherwise raised against the Philadelphia and Pottsville railway, a genuine sample, which, if properly studied, will be found unequalled, as a whole, and which cannot fail ere long to be understood.

Between Albany and Buffalo, the railways are all flat bar, and their success would seem to favor that mode of construction among the undiscriminating, but this success is owing to their being restricted to only half the functions of the railway—travel, which is slow, and rough, attended also with the worst of all feelings—that of insecurity. The heavy expenses of the travel are lost in their large receipts, but give them freight to carry, and they could not get on without a solid edge railroad.

ther the construction or management of this improvement—its present standard, and that a tolerably high one, has been reached through the trials and failures incident to all new enterprises, and by the same means, are we to look for a continued amelioration of it. The school of experience was as necessary to further the profession of engineering, as that of any other, and bating those of a merely speculative character—the more legitimate railways have been built, and most of their original defects corrected at a cost by no means disproportioned to their immense public benefit, and a fair remuneration yielded to the stockholders. There is not much grief spent over the hosts that have perished in perfecting the science of medicine ; why, therefore, regret, if it can be said that a few dollars have been wasted in advancing that of engineering ?

The second cause of too much imitation of the English by our engineers, is still less tenable. It is, as we understand it, in the other way—the later inventions about the railway, have all come from our engineers and mechanics, to which the English with their unlimited means, have been enabled to give the most effect, and they are yet behind us in several items. The *white metal*, invented by Babbott, Boston, for journals of wheels, and for all parts on which there is revolving or sliding motion, the anti friction qualities of which, to a railway, are incalculable, is yet unknown to them, and it is allowed that our locomotive, the *mainspring* of the improvement, is at least, 30 per cent. better than theirs. Our resemblance to the English, therefore, as the effect of imitation, is very faint, either in solid weight of rail, in extent of stone masonry, in straight lines, in level grades, in *inferiority* of locomotive car, and still less in profusion of ornament. How do the wooden sheds at either end of the *Camden and Amboy* road, compare with the terminations of the London and Birmingham railway ? This matter of failure is then more justly reducible :

1st. To a want, mainly, of that knowledge which is only reached by time and experience, and is natural to the inception of all new projects.

2ndly. To that uncontrollable propensity in man to turn every thing to his own selfish ends ; and railways, as well in England as here, were a favorite prey among the Vultures, so common to both countries in the past ten years of debauched morals.

Under these two potent causes of *inexperience and plunder*, surprise is not to be felt for the failure of those schemes terminating in the roads, or left there unfinished ; but the highways have had,

moreover, to bear up against the further evils of a reckless competition from rival lines and corrupt management, so that the mass of stock and loan holders finding, for the most part, disappointment, aggravated by expectations raised too high at first, have, together with the public, been *bewildered* into the conclusion that all railways must be failures, and it is scarcely possible to awake them from their stupor. Something more, however, of a spirit of inquiry is getting abroad, induced, principally by this improvement being so successful and so great a favorite in the more intelligent New England States.

To convey some idea of the sweeping nature of Mr. Trautwine's remarks on the course of our engineers, we make the following extract:

"But the American engineers, as a class, do not descend to first principles. It is enough for them, that such and such improvements have been introduced in England. Omitting all considerations of the premises, they look only to the conclusions, and the imitative faculties are forthwith called into requisition without any regard to the modifying and controlling circumstances peculiar to their own case. They dash on blindly in their operations, deluded by the impression that they cannot err if they only adhere closely to their English models.

When the engineer commences his location, his aim, almost invariably, is, to obtain the best abstract line; and whether his road is to obtain 5000 or 50,000 tons annually, the character of his grades curves, superstructure, etc., will be precisely the same. His standard of propriety is an invariable one; it adapts itself to no contingencies; it admits of no accommodation to difference of objects to be effected. It is summed up in the brief sentence, 'the English do so.'

A deficient trade has, after all, been the real rub, and for this the President, Directors, and Stockholders are certainly more responsible than the engineer, who might supervise, but whose estimate, in particular, was not to be taken as the only guide for the quality of the work. That conspiracies among them to beget large and wasteful expenditures, were occasionally formed, is scarcely to be doubted, involving in the same ruin the money of the projectors and the character of the improvement. This collusion, Mr. Trautwine admits, where he says finally, to make both ends meet an exhibit of probable revenue concocted, *to suit the report.*"

Availing himself of all the lights furnished by the trials and failures so far, Mr. Trautwine, himself, has tried to supply us with a

true model and estimate of a railway. In this, however, he carries us back to the point at which the improvement commenced, the flimsy flat bar of 24 tons per mile, or 15 lbs per yard. And of this he speaks in the following enraptured terms:—

“I entertain a high regard for the flat bar road, and conceive that the odium which has been attached to its memory has been unjustly incurred.

“Now, so far from expecting this superstructure, (as per model given,) to be knocked to pieces in a few years, as the old flat bar roads generally were I should calculate on its annual repairs being less than, perhaps, on any railroad in the United States, and that not from any inherent virtue in the road itself, but from simple fact that all its parts *are proportioned to the offices they have to perform*. We should have no crushings or difficulties here, but with its light engines, (6 ton engines used up the Winchester and Potomac road, and did little work besides.) it would be one of the stiffest roads in the Union, and, moreover, a much more agreeable one to ride on than any of those of more permanent construction. Besides which, it would annually yield 8 per cent. clear profit on its cost, when doing only the moderate business of a trip, daily, in one direction, with a small model engine, over grades of 60 feet per mile; or should the business require an eight ton engine, it would yield 12 per cent. profit on the same number of trips; or should two trips, daily, in each direction, be necessary with such loads, it would yield 24 per cent.”

Here is pretension enough to perfection, but on which he is not singular and alone, as both Mr. Ellet and Mr. Heron, make a similar claim, the first for a pure and purely wooden plan, and the second on the other extreme for one of a complicated wooden trellis consuming nearly *a forest* for each mile.

But nothing is more easy than thus in our closets to produce the results necessary to bring about our plans—the road is *there* made to cost *just so much*—ample trade and travel provided, and the charges of our own selection—their regularity ensured, and all the machinery to work *just so*. Is not this the very basis on which nearly all the engineers have acted, of whom Mr. Trautwine has been so unsparing. The clause in the above extract, modestly italicised by himself, is therefore a mere conceit, and on which in practice his scheme, like many of those of his denounced brethren, would be sure to fail, because,

1st. An engine of 6 tons* could not be relied upon to draw at all times, if at all, 30 tons gross load, over a flat bar and grade of 60 feet.

2d. The trade and travel which might *average* 30 tons daily, gross load, would often as natural to it, come in irregular and capricious quantities, varying at times, perhaps double the amount on which the other proportions of the machine had been adjusted, when there is any provision for such a call, nor is any thing allowed for an increase of traffic, which may not be far from right, for a flat bar road, although a rapid consequence of the edge railroad, and it is not difficult to make any sort of road pay, where it can dictate the charges, and make them double those usual on other roads for the same distance, as done by Mr. Trautwine.

It is therefore, that when the railway is *really called for*, the truest economy is to prefer the *permanent* to the *temporary*, itself a chief impulse to the progress of a community—its chief quality should be a provision for that progress No road, using steam, is now renewed with a flat bar, and too many we know of, that would rejoice in the means of replacing it by an edge rail.

Mr. Trautwine further says, “it is not *the best railroad*, but the *best paying railroad* that should be aimed at.”

It may be inferred that we hold the two to be synonymous; and to show that this *paying quality*, desirable as it is, is not always to be ranked first, we quote from Mr. Ellet's Laws of Trade, and subscribe freely to the views of the following extract.

“ Such works are rarely if ever undertaken, exclusively as objects of immediate speculation. Capital is too valuable here to be invested in enterprises, which can at best be expected to return a moderate interest, and that at a day so distant, that the capitalist looks upon his subscription rather as the property of *his heirs* than of himself. And in consequence, investments are seldom made in such objects with a view to the immediate profitableness of the venture, and an interest paying fund.”

* We allude to the old plan of engine, for such has been the rapid improvements of late on this machine, that it is hard to keep pace with them. Baldwin has now the model for a 6 wheeled draught engine, much simplified, the whole weight being applied as adhesion, by which one of 6 tons is made as effective as one of 10 tons of the ordinary make. The foreign engineers from Russia, Austria, &c., now here, approve highly of this model, and we hope soon to see one in actual operation on the Pottsville Railway. It is common for some engineers to abuse heavy engines, when they can only be called so, where the power that sustains them, is inadequate. An engine of 11 tons is not heavy on a 50 lb. edge rail, while one of 6 tons is so on a flat bar road, on which the great object of the railway, despatch, is neutralized; and except at enormous outlay for repairs to both road and machinery cannot be maintained on them.

This, as a general view, is the most liberal one to take; if a present sacrifice must be submitted to, it is more than made up by the indirect and ulterior advantages. And truly is exemplified in the case of the Philadelphia and Pottsville railway, the cost of which, at 5,000,000 of dollars, we will suppose, owned among the mass of coal consumers, who now require one million of tons, on which a reduction of at least 1 1-2 per ton is effected by this railway, equal to \$1,500,000 per an. or, to an indirect dividend of 30 per cent on its cost. Let this FACT be well pondered by those who talk abusively of railways, and of *this one* in particular.

From the Civil Engineer and Architect's Journal.

MR. VIGNOLES' LECTURES ON CIVIL ENGINEERING, AT THE LONDON UNIVERSITY COLLEGE.

Second Course.—Lecture IV. Laying out Railways.—In the preceding lectures the subject of the motive power had been much enlarged upon, from its necessarily influencing the manner of laying out a line. Mr. Vignoles said the student may be referred to study, at greater leisure and in detail, the principles laid down in the works of various authors on laying out both roads and railroads—M'Neill, Parnell, Navier, Tredgold, etc.—and the rules laid down by them may be taken as sound first principles, though modified at present by the improvement of motive power and other causes which could not have been known *a priori*. Railroads have so completely superseded many of the principal roads, and the public convenience has been thereby so much interfered with, that it becomes a matter of importance to run the trains as often as possible, and this becomes a new element in laying out a line of railway. Hitherto this has been done under the impression that the engines would always carry maximum loads, and though it is true that main lines radiating from the metropolis, into which a number of tributaries fall, may be laid out with a view to maximum loads, yet it becomes a consideration whether it would not be better in general to lay out railways with a view to the trains going often, and with light loads, and thereby to make the gradients suitable to the ground over which they pass. On this subject Mr. Tredgold has always judged soundly. Seventeen or eighteen years since he made various calculations on the comparative expense of ascending and descending inclined planes, and of cutting them down to a level; and he states, in his *Treatise on Railroads*, that it will be much less expensive to follow nearly the undulations of the surface, and "if a few examples (of the comparative expense) be added, it will assist in removing those extravagant notions of cutting and embankments, by which the capital of the country is wasted in unprofitable speculations." But the practice of engineers has been directly opposed to this, although we had almost a daily improvement in locomotive power, affording means of overcoming the

difficulties of steep gradients. Before determining upon the inclinations which he will adopt, therefore, the engineer should make estimates of the comparative expense of forming and working flat gradients, and gradients of an inferior description, and it will be found the gradients of 50, 60, and even 80 feet in a mile, may be advantageously introduced, especially where the traffic is not very considerable. And if lines were laid out upon these principles, instead of the traveller being overcharged with the expense of the capital sunk, as at present, he would be charged with the expense of the motive power, which bears a very small proportion to the total amount exacted from passengers. Locomotive power only is scarcely more than $\frac{1}{4}d.$ per passenger per mile, whereas the ordinary charge to passengers is $2d.$; and this may explain why railway companies do not lease the working of their lines, for they make most of their profit as carriers, and not as capitalists.

In laying out railways there are generally two distinctive descriptions of country which the engineer meets with, each of which requires a different description of treatment with respect to his operations. The first is where there is a certain summit or ridge of country to be surmounted; the rule in this case will apply both to roads and railroads—viz., to get a uniform inclination, if possible, up to the summit; but if that be not practicable, to lay out the line in stages, taking care that, having once attained any intermediate elevation, the line does not, if possible, descend again. In a country of this description there will be much more difficulty in the details than in striking out the first general idea, for it will require the greatest care and patience to lay out the line so as to ascend to the summit at the least possible expense, by winding along the sides of hills, and crossing lateral valleys and ravines to the greatest advantage, etc.

The other description of country is where the extreme points of the line to be laid are on a level, or nearly so, and the ground varies. In this case his judgment will be principally exercised in determining the general direction of the road, in taking trial levels to determine the line of least cutting and embankment, in avoiding valuable property, and in securing the largest amount of traffic; and in a country like England, which is so full of improvements, gentlemen's seats, roads, streams, etc., it is an exceedingly complicated duty to make choice of the best line under such circumstances; but it may be laid down as a general rule, that in any difficulty it is always better to incur a positive known expense, which will not entail future liability, than by diminishing the expense in the first instance to run the risk of undergoing future loss. Thus, for example, if a line of railway upon a slight embankment should cross a road on the surface of a wet and marshy country, it will be better to raise the road to a sufficient elevation to pass it over the railway, though the height of the bridge and approaches be thereby greatly increased, than by slightly lowering and passing it under the railway at a greatly reduced expense, to render it liable to be continually laid under water. And these are the kind of cir-

cumstances that require so much care and consideration on the part of the engineer, to enable him to judge of the comparative amount of cost and maintenance of the different systems which he can adopt, and to regulate his design accordingly. Now we might go on thus increasing railway gradients until they approached nearer and nearer to those of a turnpike road, were it not for the difficulty of regulating the descent of them with safety. On a turnpike road, writers have suggested that from 1 in 36 to 1 in 40 is the best slope, because horses may gallop down without danger, and, at the same time, it is a good trotting road upwards. But on railways it is not safe to go down such inclinations as that. Professor Barlow lays down that when the inclination is greater than 1 in 160, all advantage from gravity in the descent is lost, from the necessity of applying the break, and he has formed tables to show the amount of loss sustained in the ascent; thus, he states, that going up one mile of 1 in 100 is equivalent (of course with a maximum load) to going $2\frac{1}{2}$ miles upon a level; but he will not allow that any corresponding advantage is gained in the descent of this, or any plane steeper than about 1 in 180. Now, if this be the case, we must have a totally different set of elements in forming lines of railway from what I have been laying down. But, as has been already stated, this is not the case in practice, for trains can have, with perfect safety, the full benefit of gravity on all descents up to 1 in 100, and the engines seldom carry maximum loads. The same line of argument has been pursued with respect to turnpike roads, where, however, there are many circumstances in operation which do not occur on railways—such as the unsteadiness of horses and coachmen, which influence the question: but the great point to be considered is whether it is most economical to lay out railways with respect to stationary or to locomotive power. On this subject M. Navier very sensibly remarks, that great rapidity being the characteristic of railways, it has been considered necessary to employ locomotive engines, which system presents an important advantage in being able to increase gradually the number of engines as the demands of commerce require it, whereas, on the stationary system, it is necessary to provide at once for the greatest amount of traffic that can ever occur. But in the event of this increase, we have still the means of using light and frequent trains for transporting a heavy traffic over a line of inferior gradients, and reducing the charge of the interest of that capital to the public. But whatever be the description of country which the engineer may meet with, he should first of all make or procure detailed plans on the largest scale, and upon them lay down a number of surface levels, and from them, as from a model, to find the line of least expense and greatest accommodation. The magnificent Ordnance maps of Ireland, from their great scale and numerous surface levels, will render the task of the engineer in that respect easy, should the long deferred introduction of railways into the country be ever carried.

Lecture V.—On the comparative Advantages of Different Rail-

ways. The class will, no doubt, be inclined to think that I have dwelt too long in the first four lectures of the present course, upon the principles of economy in motive power, but I assure you, that if, in after years, any of you follow up the profession, you will find the subject one of the most vital importance. I shall this evening draw your attention to the different elements of comparison which should guide the engineer in forming a selection from different proposed lines of railway, and shall take, as a text book for that purpose Mr. M'Neil's translation of M. Navier's work *On the Means of Comparing the respective Advantages of Different Lines of Railway*—a work which I highly recommend for your private study, on account of the clearness and accuracy of the views it contains. M. Navier states "that the elements of comparison of different lines of railway may be divided into two heads; first, the establishment of a very rapid mode of transport—a consideration which should give a preference to the shortest lines, the velocity being supposed to be the same in all; second, the increase of wealth which may result from the establishment of a line of railway. The construction of a railway, like that of a common road or a canal, is favorable to the advancement of wealth; in the first place, because the actual expense of transport in this direction, is diminished; and, in the second place, because this diminution in the cost of transport increases the value of the neighboring properties, facilitates the establishment of new works, and increases production;" and the saving effected is not merely a private advantage to those individuals who may be directly benefitted by it, but is so much actual increase of the wealth of the country at large. "The first of these effects—that is to say, the diminution obtained on the actual cost of transport—is the cause of the second, so that this diminution is the principal circumstance, and that which should be principally considered." Taking it as established, therefore, that diminution in the cost of transport is the principal thing, we come to the result that the cost of motive power, on which this is dependent, is the leading point to be attended to in the formation of any line of railway. Indeed, M. Navier goes so far as to say that this is almost the only circumstance to be attended to; in his own words, "we should even say that the rate of reduction which is obtained upon the actual cost of transport, by the establishment of a new communication, is almost the only circumstance which should be thought of;" but he goes on to say, very justly, "it is also necessary to consider the quantity of goods which if carried, or which may be carried hereafter, in this direction," for the very essence of the railway system is to increase its own traffic; for it is evident that it may be less advantageous to the country to produce a great economy in the cost of transport upon a line where there is but little to carry, and more advantageous to produce a less economy upon a line where there is a large quantity of merchandise is carried." These are the principles which I have been endeavoring to impress upon your minds, and which from their importance,

cannot too often repeat. "It is therefore," says M. Navier, "generally necessary to take into consideration, in the comparison of different lines, the quantity of traffic which may be established on each, and even the increase in the value of properties, and the development of production to which the establishment of these lines may give rise respectively, according to the nature of the countries which they traverse." I would observe, as a passing remark, that the word *developement*, in French, generally refers to length; thus the development of a line of railway will be spoken of—meaning the length of that line—whilst, in English, the word refers to an extension of superficies. M. Navier does not go minutely into the examination of these last elements of the question, which rather belong to statistics and political economy than to engineering, but confines himself to the "consideration of the reduction which the establishment of a railway can effect upon the actual cost of transport—a most important consideration—to which, as already remarked, it is always necessary to attend; and this will form, in every case, the principal element of the comparison between different lines, and often leads to determinations purely geometrical or mechanical, and, consequently, exempt from arbitrary deductions."

M. Navier then goes on to state, that "the cost of transport on a railway, as upon a road or canal, depends on two principal points, which it is necessary to distinguish and consider separately; the first of these is the expense of constructing the railway, and the second is the expense of conveying the goods on the railway, when it is constructed. The expense of the construction of the railway is independent of the quantity of merchandise and of passengers that will pass over it. The expense of transport, properly speaking, upon the railway supposed to be constructed, depends, on the contrary, upon the quantity of merchandise or of passengers—that is to say, all other things being equal, the expense will evidently be in proportion to the tonnage." Now, a few years back, the whole time of the House of Commons was taken up with comparing the merits of rival lines of railway, for no sooner was one line proposed than directly a rival line was started. It is well known that, for the Brighton Railway, four different lines were proposed—the discussion on the respective merits of which extended over a considerable length of time. But it is a curious fact, that, in all these discussions, the principle which has been laid down this evening was never once alluded to. Now, in the practical working of railways, the diminution of expense of transport is generally quite independent of the quantity of goods carried, for, after a line is constructed, the charges are generally arranged with reference to rival lines, or to the competition which may exist with the railway; and the interest of the money laid out is scarcely thought of, however much it may have entered into the *a priori* calculations. The Paris and Versailles Railways may be mentioned; two lines were started, one on each side of the river—the

Government did not like to treat either party harshly, and passed both bills, and both lines are actually executed; and, from the great competition between them, the charges for transport of goods and passengers will probably bear little or no relation to the interest of the capital expended. There is, however, another element which renders the calculation of a very complicated nature. The railways are different from common roads or canals, over which, after they have been once constructed, the public have been left to find their own way—considerations of public safety render it necessary to incur great expenses in terminal and local stations, &c.; and there are also secondary expenses, such as the annual cost of repairs, police, and management, of which it may be said that they depend partly on the interest of the cost of constructing, and partly on the amount of tonnage carried. Now, from experience a general idea can be formed of the expense of these items, but, before going into the details, I will return to M. Navier, who says—"We may, therefore, admit, without falling into any serious error, that the annual cost of transport on a railway is, in all cases, formed of two parts—the one proportional to the expenses of the construction of the way, and the other proportional to the amount of tonnage carried; and we should also observe, that the cost of transport of one ton of merchandise cannot be specified, unless the number of tons which shall be carried annually from one extremity of the line to the other be known." Now, hitherto we have been unable to determine *a priori* what these amounts are—but we can tell with great accuracy what they have been on the different lines of railway now in operation. The following tables give the average of these expenses on several lines of railway:—

MERCHANDISE TRAFFIC.

Heads of charge.	Coal on colliery railway in the Liverpool and Manch. Rlwy.
Locomotive power—wages and repairs	0·355*
fuel	0·025
Total	0·380
Wagons	0·190
Conducting traffic	0·075
Maintaining railway	0·208
General expenses	0·100
Total cost	0·953
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* Per ton per mile—in decimals of a penny.	

PASSENGER TRAFFIC.

Heads of charge.	Lond. & Manc.	Dublin & Kings-Railw.—average town Railw.—av.
	60 passengers per train.	40 passengers per train.
Locomotive power—wages and repairs	0·170*	0·173*
fuel	0·100	0·115
Total	0·270	0·288
Coaches	0·054	0·031
Conducting coaching	0·104	0·113
Maintaining railway	0·085	0·050
General expenses	0·091	0·174
Total cost	0·604	0·656

* Per passenger per mile—in decimals of a penny.

Taking the Liverpool and Manchester Railway as an example, we find the number of passengers to average sixty per train. This may, on the whole, be considered as a fair average on all the railroads throughout the country. Seven years working of the same railway gives, as the average expense of locomotive power, 0·27*d.* or about $\frac{1}{4}d.$ per passenger per mile. The gradients do not exceed six or seven feet per mile, with the exception of the inclined plane, and this also is an average amount for most railways—in fact, fuel and wages are so nearly the same on all lines, that the expense of this head can be calculated with great exactness. The expense of locomotive power, also, is the only one which depends upon the gradients. The other expenses, which are independent of the gradients, are—coaching, conducting *ditto*, maintaining way, and general expenses, altogether amounting to 0·33*d.*, which added to 0·27*d.* = 0·60*d.*, or, in round numbers, three fifths of a penny per passenger per mile for the expense of transport. Now, let us examine the relative expense of the merchandise traffic. We have, for the expense of locomotive power, 0·55*d.*, or, in round numbers, $\frac{1}{2}d.$ per ton per mile; for the cost of wagons and secondary expenses, 1·97*d.*, which added to 0·55*d.*, gives 2·52*d.*, or, in round numbers, 2 $\frac{1}{2}d.$, per ton per mile as the actual cost of transport. Now, let us mark the very striking result of this comparison. Even with all the most recent improvements, and cutting down every expense that can be reduced, the mere transport of passengers costs three-fifths of a penny per passenger per mile, whilst that of goods is only 2 $\frac{1}{2}d.$ per ton for the same distance, and of this 1*d.* may be thrown out, arising from other sources, leaving the cost of transport—passengers, three fifths of a penny per passenger per mile; goods, 1 $\frac{1}{2}d.$ per ton per mile. In the first case, we have an amount exceedingly high, in proportion to the present means of transport, whilst the

second case presents a result as strikingly low. A ton of goods is equivalent to the weight of fourteen passengers, with 20 lbs. of luggage each.

When the loads to be carried are light, and the velocities at which they are carried considerable, the steepness of the gradients is a matter of comparatively little consequence, but as soon as the engine is loaded to its maximum power, the railway system becomes unable to compete with the canals, so far as relates to the carriage of goods. If these are the results offered to you by past experience, do you not see at once how it affects the question of laying out lines in remote districts, where but a small amount of traffic can be calculated upon? Again, referring to the table, with reference to the difference between carrying slowly and carrying quickly, we find that the expense of locomotive power on the Liverpool and Manchester Railway is 0·55*d.*, or nearly three fifths of a penny, yet that the expense upon the best railways, where goods are carried at a moderate velocity, is only 0·38*d.* and the remaining expenses 0·57*d.*, so that it comes to this, that we have—Liverpool and Manchester Railway, 2*d.* per ton per mile; other railways, with moderate speeds, 1*d.* per ton per mile. M. Navier proposes a case not quite so strong, perhaps, as might be made out, and I will, therefore, refer to the Brighton Railroad for example, the expense of which, for the 40 miles, has been about £2,600,000, or £60,000 per mile, the interest of which, at 6 per cent., is 10*l.* per mile per day, which is the net receipt, after all expenses are paid, requisite to insure a decent interest to the shareholders. I shall not enter further into the question now, but if those students who are sufficiently advanced will take up the subject, they will soon be able to appreciate my arguments for increasing the limits within which gradients are usually kept—for, supposing the expense of carrying a passenger should be only $\frac{2}{3}d.$ per mile, yet, if you will calculate the additional expense of the interest of £60,000 per mile, you will find ruinous results.

M. Navier having said that the cost of transport is the chief point to be attended to in laying out a railway, goes on to determine the amount of power requisite to draw a given train over a given railway. The elder students will, in connection with this subject, be aware of the opinion which has been pretty generally entertained amongst engineers, that a rise of twenty feet per mile is equivalent to a mile in length. M. Navier says—"Let us observe that, upon a horizontal line, the power required to draw a given weight is considered as being equal to almost the two-hundredth part of this weight; but, as I have shown in a previous lecture, the formula for the expression of this power will be $\frac{F}{n}$

taking F as the friction per ton, and n the number of pounds in each ton, so that what M. Navier calls the two-hundredth part of the weight will be friction divided by the number of pounds in a ton. Taking the friction at 9 lb., we have $\frac{9}{2000} = \frac{9}{200}$ nearly. At 11 lb.,

Mr. Vignoles' Lectures on Civil Engineering.

$\frac{1}{334\frac{1}{3}} = \frac{1}{333}$; and I must here repeat what I have so often before stated to you, that, although experiments have been made, which give so low a friction as 4 lb. per ton, that, on an average, M. Navier is nearly right, when we take into consideration the numerous causes of friction. M. Navier considers the power acquired to draw a given weight "to be independent of the absolute velocity of transit, although there is reason to believe that the tractive power increases with the velocity." Now, it has been said that the friction is the same at all velocities. I cannot fully concur in this opinion. I think the axletree friction may be constant under all velocities, but that, from other causes, there appears to be, I will not call it increase of friction, but an increase of resistance, the amount of which has not been satisfactorily determined. M. Navier goes on—"We conclude from this, that, in order to transport, with any velocity whatever, constant or variable, a weight, W, to a distance represented by a on a horizontal line, it is necessary to employ the power represented by $\frac{W}{333} \times a$ —that is to say, the power necessary to raise the weight to the height $\frac{a}{333}$ " or, in other words, to transport a weight any given distance, on a horizontal line, is equivalent to raising it the two-hundredth part of that distance in vertical height; and, although this is not quite correct, it is sufficiently so for general purposes. We have before assumed that it is the same thing to go a mile round as to go over a hill rising twenty feet in a mile. Now, a mile being 1760 yards, or 5280 feet,

we have $\frac{W}{333} \times 5280$ as the power required, which is equal to raising the weight 26 feet. But as the friction varies, I think we have sufficient experience now to say it is about the same thing to rise 30 feet in a mile as to go a mile round; but this is quite independent of the question, whether you should or should not allow on one hand, and deduct on the other, when the slope exceeds the angle of repose. I have explained to you, on previous occasions, the difference of opinion that exists on this point. Both Mr. Barlow and M. Navier allow the advantage up to a certain point, which they fix at about 1 in 180, beyond which point they consider the whole advantage gained to be destroyed by the necessity of putting on the break. Now, in practice, we do not find this to be the case, until we come to 1 in 80, or thereabouts; however, we may take, as a general rule, M. Navier's concluding words on this subject:—"The length of the line remaining the same, the amount of power consumed to effect the transit depends entirely upon the length of the line, and the difference of the level of its extreme points." The practical result which I have endeavored to lay before you this evening is, that the cost of transport is the cost of the power combined with the interest of the original cost of the line, and that the calculation of this combined expense must form the element of comparison between different lines of railway.

INSTITUTION OF CIVIL ENGINEERS.

Description of the Mill, Forge, and Furnaces of a Welsh Iron Work.
By THOMAS GIRDWOOD HARDIE, Assoc. Inst. C. E.

The author commences by describing the general plan of an iron work, consisting of six blast furnaces, four double-fire refineries, and a forge and mill, capable of converting into bar iron the produce of the six blast furnaces. He then enters very fully into certain alterations of the interior shape of the blast furnaces introduced by him at the Blaenavon works, from which have resulted an economy of fuel, regularity of work, and an improved quality of iron. The principal alterations appear to be, making the interior diameter greater above that at the boches, and establishing a proper ratio between the diameter of the boches and that of the charging place, and proportioning both to the height of the furnace. The opinions are supported by calculations of the quantity of blast used in smelting given quantities of ore, and the effect which the form of the furnaces must have in directing the current of the blast through the materials, by which also the point of fusion would be necessarily affected, and the chemical combinations varied. The particulars are then given of the construction of the furnaces at Blaenavon, and the details of the blowing engines, blast mains, regulators, valves, &c., with calculations of the quantity of blast used in the various processes of the manufacture. The construction of the casting houses, with the mode of ventilating by the iron roof, is detailed. The general arrangements of the balance pits, coke yards, mine kilns, and bridge houses, are shown, and the author proceeds to describe the forge and mill, which have 35 puddling furnaces, with hammers, shears, rolls, and heating furnaces in proportion. He then condemns the usual practice of leaving the coupling boxes loose upon the spindles, as liable to break the rolls, shafts, or machinery, and gives the theoretical and practical reasons for preferring fixed couplings. The communication is illustrated by three drawings, showing all the details of construction of the iron works.

Remarks.—Mr. Lowe believed that there was an incorrectness in the statement of the iron, after being freed from its oxygen by the heat of the furnace, taking up a dose of carbon from the coke, thus becoming a carburet of iron, which is a fusible compound, and as such fell melted into the hearth. On the contrary, he thought that the iron was combined with carbon in the ore, and that there was not any necessity for the medium of the fuel to charge it with carbon.

Dr. Farraday, in reply to "Why the ore required, or why the iron carried away any of the carbon of the fuel?" stated, that the ore being essentially a carbonate of iron, the first action of heat, either in the mine kilns or in the furnace, was to draw off the carbonic acid and leave an oxide of iron, and then the further action of the fuel (besides sustaining a high temperature,) was to abstract the oxygen of the oxide, and so to reduce the iron to the metallic

state, after which a still farther portion of the carbon of the fuel combined with the iron, bringing it into the state of easily fusible or pig iron. As carbon can be communicated to the iron in two ways, distinct in their nature, either by contact with solid carbon, as in the process of cementation (that by which steel is commonly converted), or from the carbonated gasses, either carburetted hydrogen, or carbonic acid, which occupy nearly every part of the air-way of the furnace, it would be desirable to distinguish, as far as may be in any furnace having a particular form or action, what proportion of the whole effect is due to the one mode of carbonization or the other.

Mr. Wallace stated that the ore was a carbonate of iron, or a protoxide of iron and carbonic acid united, and not a carburet of iron (or iron and carbon simply), as was generally believed. In smelting, the carbonic acid was driven off, the simple oxyde remaining; the oxygen of which, being carried off by the heat, left the pure iron, which, combining with the carbon of the coke, formed a fusible carburet of iron, or the pig iron of commerce.

Mr. John Taylor observed that his brother, Mr. Philip Taylor, being sensible of the advantages to be expected from the use of anthracite in smelting iron, made a series of experiments several years ago, from which he derived the opinion that the carbon absorbed by the metal, and which is necessary to produce it in the shape of pig iron, must be presented in a gaseous state to the mass in fusion; and as anthracite did not afford a sufficient supply of coal gas during combustion to produce the proper effect, he proposed to adopt a very ingenious method, by which this gas would have been thrown into the furnace in such proportions as might be found necessary, mixed with the common air employed as the blast. Circumstances interrupted the course of these experiments, or it is possible that the use of anthracite for this important application might have taken place at a much earlier period than it has happened to do.

*Description of Chelson Meadow Sluice. By THEODORE BUDD,
Grad. Inst. C. E.*

The sluice which is described in this communication was erected from the designs of Mr. Rendel, for the Chelson Marshes in Devonshire, which, being very low, had previously suffered much from floods, but now are entirely relieved. The novelty in the construction consists in hanging each of the doors respectively by two hinged flat bars of iron, of 18 ft. 6 in., and 15 feet 3 in. in length, and thus, by placing the centre of motion so high above the centre of gravity of the doors, give greater freedom of action than by the modes usually adopted in similar works. The dimensions of all the parts, and the method of construction, are given in great detail, and are illustrated by a drawing.

Remarks.—Mr. Rendel explained that the sluice doors which had been superseded by those described by Mr. Budd, were of the ordinary description, placed side by side. They were frequently

hinge bound and clogged up; which caused the land to be flooded sometimes for three months during the year; the hinges were attached in the usual manner to the frames, close at the head of the doors, and they required a pressure of at least 6 inches of water to act upon them either way. He considered the principal advantages of these doors to consist in the freedom of action given by the length of the bar hinges by which they were suspended, their giving the full extent of opening, and the pressure of one inch head of water sufficing either to open or close them.

Mr. Prior inquired whether there was any similarity between these sluice doors and that erected by the President near Blackfriars Bridge, at the bottom of Fleet Ditch. That door was so well hung as to be even acted upon by the wind; and the slightest pressure of water sufficed to open or to close it.

The President explained that the principle was not the same; at the Fleet Ditch sluice double hinges were used, or rather hinges with a link between the part attached to the frame, and that which was screwed to the door;—that form of hinge always acted freely, and allowed the doors to open with a slight pressure.

On the mode practised in India for obtaining solid foundations for bridges, &c., in sandy soils, by means of wells. By CAPTAIN GOODWIN, B. E., Assoc. Inst., C. E.

Piling for the foundation of buildings appears to be entirely unknown in Hindostan; the ordinary mode for securing a foundation, where the substratum is tenacious and rests upon loose sand, is to dig a well until water is reached; a curb of timber is then placed, and upon it a cylinder of brick, 7 1-2 feet exterior, and 3 1-2 feet interior diameter, is built to the height of 3 or 4 feet above the ground. As soon as the masonry has hardened sufficiently, the well-sinker fixes a plumb line to the top of the cylinder as a guide, and descends withinside, carrying an instrument called a "Phaora, or Mamooti," somewhat similar in shape to a hoe; with this he excavates the earth until the water is too deep; he then commences the use of the "Jham," which resembles the "Phaora" in shape, but is about 36 inches long and 27 inches wide, and is suspended to a cord passing over a pulley above the cylinder. Upon this instrument the well-sinker decends, and diving into the water excavates with the "Jham" the soft earth under the sides of the curb, and is at intervals drawn up with the instrument. The cylinder descends gradually from 6 inches to 2 1-2 feet per day, as the earth is withdrawn from beneath it, and relays of workmen keep it constantly going, lest the sand should settle around it, and cause it to hang up. The natives are very expert in this operation, and not unfrequently remain under water more than a minute at a time. The cylinders have been sunk as deep as 40 feet: but with extreme labor.

A series of these wells being sunk at intervals of 1 foot between them, they are filled with a grouting of lime and rubble stone, and

separately arched over ; arches are then thrown transversely from the centre of each parallel pair, and another set of arches turned over the adjacent wells longitudinally ; the whole is then covered with masonry, and the pier or other building raised upon it ; such foundations are found to answer perfectly in situations where almost any other kind would be washed away.

The communication was accompanied by a drawing of the process, and of the tools used, showing also the modification of the system proposed by Colonel Colvin, of the Bengal engineers, for obtaining foundations for a curtain, or line of wall, by sinking square masses of brickwork, with two or more wells in each, through which the workmen could excavate the soil.

In answer to questions from the President, Captain Goodwin observed, that the greatest peculiarity of this system was that the sinker worked under water ; such had been their custom for ages. Upon this kind of foundation, many of the large fortresses in India were constructed, and they stood remarkably well ; whereas, if timber piles had been used, the white ant would have destroyed them in a short time.

Lieutenant Sale observed that another main reason for not using piles was, that timber was scarce and dear, whereas labor was plentiful and cheap. Hence the general use of brick cylinders.

Mr. Parkes conceived the most ingenious part of the proceeding to be, the sinking through the water, and thus avoiding the risk of bringing up large quantities of sand, and the combination of arches for distributing the weight of the superstructure equally among the brick shafts. Such shafts had been used by the Chinese, and sunk in the same manner from time immemorial.

In answer to a question from the president, Mr. Simpson described the process now so much practised for sinking wells through bad strata by means of cast iron cylinders ; excavating the earth from within the cylinder by an instrument called a "miser," which is a conical iron shell with a valve opening inwards ; it is suspended by iron rods $1\frac{1}{2}$ inch square, and worked from the level of the ground without pumping up the water : it is not uncommon to excavate to a depth exceeding 100 feet in that manner. The "miser" can bring up a cubic yard of earth each time it is raised. Cast iron cylinders are preferable to brick shafts, which frequently hang up, and in that case give much trouble, whereas if the iron cylinders do not descend freely, they will bear the application of considerable force to drive them down. They are frequently forced through the indurated ferruginous gravel. Light planking is also sometimes used, particularly in such cases as in the well he is now sinking at Chelsea, which is 20 feet square, lined throughout with 3 inch planking. It has reached the quick sand at a depth of 32 feet, and will be stopped there.

Mr. Davison had just completed a well at Messrs. Truman and Hanbury's brewery, with cast iron cylinders, 8 feet diameter, and 193 feet deep, an account of which he promised to present to the Institution.

The President was now sinking a set of cast iron cylinders through sand which was liable to be washed away; they were to be filled with concrete and used as the foundation for a lighthouse at the Point of Air. An account of the construction was, he believed, preparing for the Institution.

REGULATIONS ON RAILWAYS IN FRANCE.

The Minister of public Works, in conformity with the opinion of the committee on steam engines, has provisionally issued the following orders :

1. The employment of locomotives on four wheels is forbidden with passengers' trains.
2. Neither tender nor any other carriage on four wheels to be placed at the head of the trains before the locomotives.
3. The locomotives to be placed at the head of the train, and never behind.

This regulation never to be violated, except in case of changing the direction of the trains at the stations, or in case of a train being stopped by accident, and that it should be necessary to send assistance from behind the train; but in such case the speed of the train not to exceed 22 kilometres the hour (13.7 miles).

It is, moreover absolutely forbidden to enclose a train between two locomotives, one before and the other behind.

4. Until a better mode shall have been discovered to diminish the effect of shocks and collisions, there shall be placed one wagon without passengers at the head of each train, composed of five carriages at most, and of two wagons, when the number of carriages in the train shall exceed five.

5. The passengers' carriages never to be locked.
6. Every railroad company to keep books, in which shall be entered the state and length of service of every axle-tree, whether straight or curved.

7. The Prefect will publish an ordinance, stating the interval at which two trains are to succeed each other.

8. The speed of the trains in their descent from Versailles to Paris, on either line, not to exceed 390 kilometres per hour (24 miles.)

Independently of the above measures, the Minister of Public Works has requested the committee on steam engines to examine—

1. Whether in the descent from Versailles to Paris, and in fact in all rapid descents, it would be adviseable to prohibit the use of more than one locomotive, and, if not, under what regulations they should be tolerated.

2. To discover the best mode of preventing inflammable matter from being communicated by the locomotives.

The Minister is moreover about to appoint a special commission to make experiments—

1. Upon the degree of perfection to which the axletrees of locomotives may be brought, and the length of time they ought to remain in use.

2. Upon the different means to be employed in order to diminish the effects and danger of collisions on railroads.—*Ib.*

VELOCITY OF WATER THROUGH PIPES.

(From Report of Lecture by Dr. Melson in the Medical Counties Herald.)

The calculations for the head of water necessary to keep up a given velocity for every 100 ft. run of pipe, have been so ably deduced, from experiment, by Mr. Rose, of the Birmingham Waterworks, that the lecturer could not forego the pleasure of pointing them out a little more in detail, and of giving the tables by which the necessary calculations were effected. The tables were two, and were both deduced from absolute experiment—not from experiments conducted by means of tin tubes of small diameter, fit only for laboratory uses, as there was too much reason to fear many of the tables previously published had been constructed, but from the absolute cast iron tubings themselves, as laid down in Birmingham and its vicinity. The tables were two: in the first, V represents the table of velocities in feet per minute, and T the constant numbers of those velocities:—

V	T
60	8.62
70	11.40
80	14.58
90	17.95
100	21.56
110	25.35
120	29.70
130	34.
140	38.90
150	44.
160	49.50
170	55.66
180	62.13

In the latter D represents the diameter of the pipes in inches, and t the constant numbers for those diameters:—

D	t
3	.028
4	.053
5	.078
6	.104
7	.134

As an application of these tables, the following problem was proposed; it having been premised that the formula for their use was

$$\frac{T}{D \times t} = H$$

where H represents the height, or head of water. It is required, then, to determine what head of water will be necessary to send water by an engine through 1,500 ft. of six-inch pipes to an elevation of 80 ft. at a velocity of 180 ft. per minute. Now, by the table we see that the constant number for 180 ft. velocity is 62·13, and the constant number to be added to 6 inches is .078,

$$\text{and } \frac{62\cdot13}{6\cdot078} = 10\cdot22 \text{ inches.}$$

which is the head of water required to keep up the velocity of 180 ft. per minute for every 100 ft. run; which being multiplied by 15 (the number of hundred yards through which it has to pass), gives 153 in., or 12 ft. 9 in. This, added to 80 ft., will give 92 ft. 9 in. as the column of water which the pump must lift.—*Ib.*

AMERICAN MARINE ENGINES.—We have been both astonished and gratified by the reception of a drawing sent to us from America, of an excellent side lever marine engine, constructed by Messrs. Stillman and Co. of New-York, for two steamers built for the Spanish Government, “El Regent” and “El Congresco.” It has been so much the habit of Europeans to regard the American machinery as rude and dangerous, as well as unsuited to vessels intended for the navigation of the ocean—an impression in which, to a certain extent, we ourselves participated—that this drawing has, we confess, surprised as much as it has delighted us; and it is an act of justice we feel called upon to render to say that, so far as this drawing will enable us to form an opinion, Messrs. Stillman’s performance will not suffer by a comparison with the work of even the first of British manufactures. The framing of this engine resembles the framing of Messrs. Fawcett, Caird, and Borrie, and every part of it appears to us well proportioned and arranged. The ingress and egress of the steam to and from the cylinder is regulated by spindle valves wrought by an eccentric; whether these valves are of the single or double beat description, the drawing does not specify. The eccentric rod is provided with a long nut furnished with a right-handed and left-handed thread, so as to shorten or lengthen the rod at pleasure. There is an expansion valve of the common description situated in the steam pipe, and wrought in the usual manner. We should have been glad to have possessed more precise information respecting the interior of these engines, as for example, the nature of the piston packings of the valves, air pump buckets, as well as some particulars respecting the construction of the boiler, the consumption of fuel, and the nature of the performance as determined by the indicator. We trust we may be favored with such details, and no effort of ours shall be wanting to make the merits of the machinery of America as extensively known and as highly appreciated as its excellence appears to deserve.—*Ib.*

THE TARTARUS steam vessel, Commander T. W. Smith, arrived at Woolwich on Monday, April 23, from the West Indies. She has

been upwards of four years in commission, traversing during that period a distance of 73,000 miles, and consuming about 5400 tons of coal, without, in a single instance, being detained one hour from service for repairs to either hull or boilers.

RAILWAYS IN FRANCE.—The Chamber of Peers assembled on Monday, 9th May, in their committee rooms, for the purpose of electing a committee to report on the railway bill, brought up from the Chamber of Deputies. This bill contains—first, a general classification of the lines intended to be constructed : second, a secoud system of execution, which imposes on the departments traversed by those railways the payment of two-thirds of the value of the ground to be purchased. It likewise enacts that the Government shall pay the remaining third, together with the expense of embankment, the executions of works of art and stations, leaving the cost of fixing the rails and the *materiel* to the charge of the companies who shall undertake to complete them. Third, the allocation of funds amounting together to the sum of 126,000,000f. applicable to the following sections :—

	Francs.
From Strasbourg to Hommartin, - - - - -	11,500,000
" Dijon to Chalons, - - - - -	11,000,000
" Marseilles to Avignon, - - - - -	30,000,000
" Orleans to Tours, - - - - -	17,000,000
" Orleans to Vierzon, - - - - -	12,000,000
" Paris to Lille, - - - - -	43,000,000
For sundry expenses, - - - - -	1,500,000
	<hr/>
	126,000,000

The entire plan consists of seven of the first order, setting out from Paris, and leading—1 to the Belgian frontier through Lille and Valenciennes. 2. To England, by one or several points on the coast, to be hereafter determined. 3. To the German frontier, through Strasburgh. 4. To the Mediterranean, through Lyons, Marseilles, and Cete. 5. To the Spanish frontier, through Bordeaux and Bayonne. 6. To the Atlantic Ocean, by Nantes. 7. To the centre of France, through Vierzon, with a prolongation to be hereafter determined, with a branch to Bourges. And of two lines of the second order, from frontier to frontier directed—1. From the Mediterranean to the Rhine, through Lyons, Dijon, and Melhouse. 2. From the Mediterranean to the Atlantic Ocean, through Bordeaux, Toulouse, and Cete.—*Ib.*

THE HON. COMPANY'S STEAM FRIGATE ACBAR.—On Sunday noon, the 15th ult., this splendid war steamer left her anchorage at Gravesend, bearing the pendant of Commodore Pepper, of the Indian navy, who will assume the command of all the Company's ships-of-war now serving in China, under Admiral Sir W. Parker. The Acbar is a steam frigate of the first class, armed with two eight-inch guns, and four long 32 pounders, with a complement of

160 men, carrying five boats, on two of which are mounted brass 12 lb. howitzers. The engines are of the collective power of 350 horses, manufactured by Robert Napier of Glasgow, and are of a very superior description. She has four copper boilers of about seven tons each. The armoury is filled up with 100 percussion muskets, pistols, cutlasses, and musketoons, etc., the whole in beautiful order, and presenting a most warlike appearance. The *Acbar* carries 500 tons of coal, which, with a consumption of a ton an hour, will enable her to steam 20 successive days. She made her passage from Gravesend to Falmouth, a distance of 370 miles, in 36 hours, which gives an average speed of more than ten miles an hour.—*Ib.*

STEAM NAVIGATION ON THE THAMES.—There are now 16 steam vessels running daily between Gravesend and London, the same number to Woolwich, 20 to Greenwich, numerous small steamers, the boats of the Waterman's Company, and of the Old Woolwich Company—between Greenwich and Blackwall; there are eight steam vessels constantly going up and down the river on their way to and from Dover, Ramsgate, Herne Bay, Southend, and Sheerness. The General Steam Navigation Company musters 49 steamers, all sailing from London, a fleet superior to the steam fleet of any of the continental powers, and which carry merchandize and property to the amount of 1,000,000*l.* sterling weekly, and whose consumption of coals exceeds in value 50,000*l.* per annum. There are not less than 50 other large steam vessels trading between London and various ports in Great Britain and Ireland; 23 steam-tugs carrying from 30 to 100 horse power each, exclusively engaged in towing ships between Gravesend and the Pool; 20 iron and wooden steamers navigating the river above bridge, between London Bridge and Chelsea; 2 constantly running between the Adelphi Pier and Putney, and 5 to Richmond.—*Ib.*

SCOTT'S MONUMENT.—An engraving has just been published, from a drawing by the architect, Mr. Kemp, of the monument to the memory of Sir Walter Scott, at Edinburgh. It is a Gothic elevation, something in the style of what are called "crosses," and bears in some portions a resemblance to the great tower of the Cathedral at Antwerp. It is in style between the florid and the simple Gothic, having flying buttresses, finials, crockets, etc., and being ornamented with quatre feuilles, and more minute embellishments. There are many tabernacles, but they are not occupied by figures. The statue of Sir Walter is placed in the centre, beneath the principal arch; it is robed in a flowing drapery, and stands on a pedestal. The pedestal does not partake of the character of the building, and gives rather an incongruous effect to the whole. There is an appearance of lightness and elegance about the design, but it may be questioned whether the building has not too much of the monastic or clerical style to suit exactly the character of him it is intended to commemorate.—*Ib.*

ARTESIAN WELL IN LONDON.—The sinking of the Artesian well in Piccadilla has, we believe, been attended with the most perfect success, and there is now every probability of an exhaustible supply of the purest water. After boring to a depth of 240 feet water was arrived at, which immediately rose to within 80 feet from the surface. Over the well a handsome iron pump is in progress of erection, and the inhabitants may now reckon upon a certain and plentiful supply of fine spring water. The expense of this useful work is estimated at 600*l.* Such as has been the success of the undertaking, and so many the advantages, that it is said to be in contemplation to carry out the plan in St. George's parish, by causing Artesian wells to be sunk in different localities, best calculated to contribute to the convenience of the parishioners.—*Ib.*

WELLAND CANAL.—NEW STONE LOCKS.—We are informed on the authority of a letter received from Mr. Killaly by the engineer in charge of the New works on the Welland Canal, that, in consequence of advices received from England by the steamer *Caledonia*, at the Government House, Kingston, of a full guaranty of abundant means from the Home Government, preparations are to be made for the immediate commencement of the enlarged stone locks on this work, six of which, near the mountain ridge, a guard lock at the junction, and a ship lock of 185 by 45 feet within the chambers, at Port Maitland, (Broad creek,) will shortly be placed under contract, to be finished with all reasonable despatch.

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MORRIS CANAL.—We learn that the Receivers have leased the Morris Canal to Lewis S. Coryell, Esq., who is now busily engaged in completing the repairs, and expects to have it ready for navigation by the first of next month. This canal runs from Easton to Jersey City, through the immense iron region of New Jersey. It cost above four millions of dollars. The company became insolvent, and the property went into the hands of Receivers, by order of the Chancellor of New Jersey. The notes issued by the company are not receivable for tolls on the canal.

LETTERS IN THE ALPHABET.—The Sandwich Island Alphabet has 12 letters; the Burmese 19; the Italian 20; the Bengalese 21; the Hebrew, Syriac, Chaldee, Samaratin and Latin 22 each; the French, 23; the Greek 24; the German and Dutch 26 each; the Spanish and Slavonic 27 each; the Arabic 28; the Persic and Coptic 32; the Turkish 33; the Georgian 36; the Armenian 38; the Russian 41; the muscovite 43; the Sanscrit and Japenense 50; the Ethiopic and Tartarian 202.—*Savannah Georgian.*

Among the strange craft that navigate the Ohio, is a floating glass manufactory. A large flat boat is filled up with a furnace, tempering oven, and the usual apparatus proper for such an establishment. It is in full blaze every night, melting glass ware, which is retailed all along shore, as the establishment floats down stream. It hails from Pittsburg, and is owned by Ross & Co.